91602
new 82-10

COMPLIMENTARY COPY
Please Credit Ontario Hydro Research if
Reproduced in Whole or in Part

ontario hydro
research division

To: Mr. J.V. Doyle
Manager
Civil Works Department
Thermal Hydraulic Generation Division

Attention: Mr. I. Azis

Des Joachims GS
Proposed New Instrumentation 1986

C.B.H. Cragg

1.0 INTRODUCTION

As part of the Instrumentation task of the Dam Safety Program, a review of the instrumentation at the Des Joachims hydraulic project was performed, at the request of Civil Works. This report documents the current instrumentation at the project, identifies any unusual features or behavior of the project structures and recommends installation of new devices to monitor the performance of this project's dams.

2.0 PROJECT DESCRIPTION

Constructed on the Ottawa River in 1950-51, the Des Joachims project consists of three major concrete gravity dams and a small side (freeboard) dam. Figure 1 shows the locations of these works. The main dam has a maximum height of 180 feet and a crest length of 2332 feet. An auxiliary dam is located a few hundred feet away from the main dam, across a rocky knoll. The auxiliary dam has a maximum height of about 50 feet and a crest length of 1100 feet. McConnell Lake Control Dam, located about three miles from the main dam, has a maximum height of 130 feet and a crest length of 1620 feet. Together these structures impound a reservoir of 1,042,000 acre-feet.

3.0 EXISTING INSTRUMENTATION

3.1 Main Dam

Two sets of uplift pressure cells and one normal pendulum were installed in the main dam at the time of construction. Each set of uplift cells consists of six individual cells installed at the rock to concrete interface at the base of the dam. The uplift cell sets are located at stations 12+30 and 23+08. The pendulum is positioned at 23+18 in the

gravity section between the headworks and log chute. Construction details for these devices and early readings are given in/1,2,3,4/.

During an inspection, on March 24, 1986, two brass survey caps (of six believed to exist) were found under the snow on top of the headworks and a concrete survey benchmark (Figure 2) was found on the left bank. This alignment survey system does not provide any measurements on the gravity portions of the structure. An inspection tunnel and foundation drainage system permit visual monitoring of dam leakage.

3.2 Auxiliary Dam

This dam has no instrumentation or internal observation facilities.

3.3 McConnell Lake Control Dam

This dam contains no instrumentation but does have an inspection tunnel and a foundation drainage system for visually observing leakage. Six inch diameter grouting pipes extend to foundation rock at tunnel chainages 2+81, 3+66, 8+02, 8+64, 9+27, 9+43, 10+21 and 10+82. These pipes could be used for piezometric monitoring if their top caps were removed.

3.4 Condition of Existing Instruments

A 1984 review of the site/5/, indicated that the uplift cells were functioning properly and that readings in 1981 and 1983 were similar to those recorded in 1952. More recent readings show no change from this pattern/6/. The condition of the normal pendulum has significantly deteriorated (Figure 3). Repairs are required to return this unit to service/7/ and the reading system requires modification to permit Regional staff to perform the monitoring.

Relatively high water levels are present in the drainage system risers in the headworks portion of the main dam inspection tunnel. As no flow occurs at these locations the accuracy of these readings should be confirmed by bailing and/or flushing the drainage system. Flushing of the drainage system was requested in 1985/8/ but does not appear to have been performed to date. At McConnell Lake Dam the risers are both full and flowing. The gutter in the inspection tunnel is transporting an estimated few hundred gallons per minute to downstream outlet pipes. The top caps are rusted on the eight grouting pipe "observation wells".

3.5 Missing Instrumentation

Apart from the normal pendulum and survey points, no instruments are provided for deformation monitoring of these dams. The existing facilities have not been monitored for many years. McConnell Lake Control Dam has no uplift pressure monitoring devices or weirs for measuring flow in the inspection tunnel gutter.

4.0 UNUSUAL CONDITIONS

These dams are now performing satisfactorily according to the inspection reports but two areas of concern exist. First, the leakage occurring within McConnell Lake Control Dam requires surveillance and may require future treatment should it increase. Second, undercutting of Sluice #1 at this dam has been developing since 1962/9/. Repairs for this area are currently being formulated.

5.0 PROPOSED NEW INSTRUMENTATION

Installation of the following instruments is recommended to assess unusual conditions, provide missing performance data and support future safety assessments.

5.1 Main Dam

For monitoring deformations of the main dam a system of internal pendulums and external surveying is proposed consisting of:

(a) one normal pendulum,
(b) one inverse pendulum, beside the normal pendulum,
(c) eleven survey monuments on the dam deck for elevation and alignment surveying, and
(d) two benchmarks on the abutments as reference for the alignment survey.

Flushing of the drainage system should be performed to confirm readings.

5.1.1 Normal Pendulum

Rehabilitation of the existing pendulum is the most economical approach to monitoring deformation from the inspection tunnel level to the dam deck. No convenient vertical openings exist in the headworks area which is a slightly better location for this monitoring. The rehabilitation should include replacing the pendulum reading table so that Regional staff can monitor movements with a depth micrometer. An invar wire extensometer should be added to the device to permit monitoring of vertical movements and to serve as a reference for elevation surveys of the top of the dam. Pendulum weights, wire, dashpot oil and rainguard should also be refurbished.

5.1.2 Inverse Pendulum

An inverse pendulum should be installed to a depth of 90 feet below inspection tunnel level and should be located next to the existing normal pendulum at 23 + 18. The construction of this device should be the same as that installed at Abitibi Canyon/10/.

5.1.3 Survey Monuments

Survey monuments, consisting of standard 3 inch diameter brass caps should be installed at 200 foot intervals along the top of the dam for alignment and elevation surveys. One monument should be placed next to the top of the normal pendulum so that it is tied in to the survey. The locations for the monuments shown in Figure 4 (Plan A) should be adopted if the existing alignment points allow the gravity sections to be sighted. If the existing alignment is not usable, the monument positions shown in Figure 5 (Plan B) are recommended. A field theodolite survey is required to make this selection and to initially layout the positions for these monuments on line within 0.25 inch.

5.1.4 Benchmarks

Should the existing alignment be workable for the gravity sections, the existing left abutment benchmark (Figure 2) and its assumed mate on the right abutment should be used for instrument and target stations. Failing this, new benchmarks consisting of standard brass caps, should be installed in the rock abutments at the ends of the dam.

5.2 Auxiliary Dam

Deformation monitoring, in the form of an alignment and elevation survey, is recommended for this structure. Five brass cap monuments, placed at 200 foot intervals along the top of the dam, and two brass cap benchmarks are proposed (Figure 5). The benchmarks would be located at the ends of the dam where it is cradled in the abutment rock. The initial positions of these monuments and benchmarks should be laid out by a theodolite survey to ensure they are in line within 0.25 inch.

5.3 McConnell Lake Dam

McConnell Lake Dam requires instrumentation to monitor uplift pressures, leakages and deformation. For uplift pressures, two cells located at chainage 7+50 and two cells located at chainage 10+00 are recommended. Of each pair, one cell would angle upstream at 20° and one downstream at 30°. These cells would be drilled 20 feet into the rock below the base of the dam (Figures 6 and 7) resulting in hole depths of approximately 40 feet. The locations and angles of these holes should be checked to ensure that no contact is made with services embedded in the concrete. Corrosion resistant packers equipped pressure gauges and bleed valves should be installed in these holes if a water head above inspection floor level is encountered.

For leakage monitoring, four weirs should be installed in the inspection tunnel gutters at 7+90 and 11+00 (Figure 7). An inspection of these locations and discussions with the Regional staff are necessary to produce a design for these weirs. Snow and ice prevented access to this tunnel during a site inspection in late March 1986.

Deformation monitoring would require a system of pendulums and surface surveys similar to that for the main dam. This system would include one normal pendulum, one inverse pendulum, seven survey monuments on the dam and two reference benchmarks.

5.3.1 Pendulums

The pendulums should be located in one of the widest sluice piers at chainage 6+00. Installation of the normal pendulum will involve drilling about 85 feet from the top of the dam to the inspection tunnel. The inverse pendulum should be drilled about 65 feet below inspection tunnel level in order to penetrate 50 feet into the foundation rock (Figures 6 and 8).

Hardware and installation details for these devices are described elsewhere/10/. Clearances should be obtained for these drilling locations to avoid damage to services embedded in the dam.

5.3.2 Surveys

Seven brass caps should be installed at 200 foot intervals across the top of the dam for alignment and elevation surveys. The proposed locations for these monuments and the two off dam benchmarks are shown in Figure 9. One brass cap should be located beside the normal pendulum so that it is tied in to the survey. These brass caps and benchmarks should be laid out with a theodolite to initially position them in line within 0.25 inch.

6.0 SUMMARY

The new instruments shown in Table I should be installed to provide needed deformation, uplift and leakage data at the Des Joachims hydraulic project. In addition the existing normal pendulum in the main dam should be repaired and modified. Removal of the grout pipe top caps is proposed at McConnell Lake to allow these pipes to be used as observation wells.

Approved by:

T.W. Klym
Manager
Civil Research Department

Prepared by:

C.B.H. Cragg
Senior Engineer
Soil Sciences Section

Reviewed by:

T.J. Carmichael
Supervising Engineer
Soil Sciences Section
Civil Research Department

CBHC:LM

REFERENCES

1. Gung, G. and Morison, W.G. "Installation Report - Dam Instrumentation Program". Research Division Report No 52-451, 1952.

2. Morison, W.G. "Uplift Pressures in the Commission's Concrete Dams". Research Division Report No 52-452, 1952.

3. Gung, G. "Uplift Pressures in the Commission's Concrete Dams - Progress Report No 2". Research Division Report No 55-446, 1955.

4. Gung, G. and Morison, W.G. "Measurement of the Structural Behaviour of Concrete Gravity Dam". Research Division Report No 54-533, 1955.

5. Ng, W.H. "Des Joachims GS - Main Dam Annual Review of the Foundation Drainage System and the Uplift Pressure (1984)". FIling Memorandum, Civil Works File HCG-NA5-20001, Feb 1985.

6. Unnumbered plots of uplift pressure versus time, Civil Works drawing files.

7. Percival, E. and Smith, G.F. "Des Joachims Development - Phase I Inspection Report". Unnumbered Civil Works Report, Civil Works File No R-NA5-20001-1, April 1980.

8. Steckley, H.M. "Des Joachims GS - Main Dam and McConnell Lake Dam Annual Review of Foundation Conditions (1984)". Memo to A.J. Fort, Civil Works file HCG-NA5-20002, Feb 1985.

9. Macdonald, J.A. "Inspection of Concrete, McConnell Lake Dam, Des Joachims Generating Station". Research Division Report No 63-39, 1963.

10. Cragg, C.B.H. "Abitibi Canyon GS - Main Dam Selection and Installation of Deformation Monitoring Instruments". Research Division Report No 86-63-K, in preparation.

TABLE I

Proposed Instruments

Instrument	Structure Main Dam	Auxiliary Dam	McConnell Lake Dam
Benchmarks	2	2	2
Survey Stations	11	5	7
Normal Pendulum	(repair)	-	1
Inverse Pendulum	1	-	1
Uplift Cells	-	-	4
Weirs	-	-	4

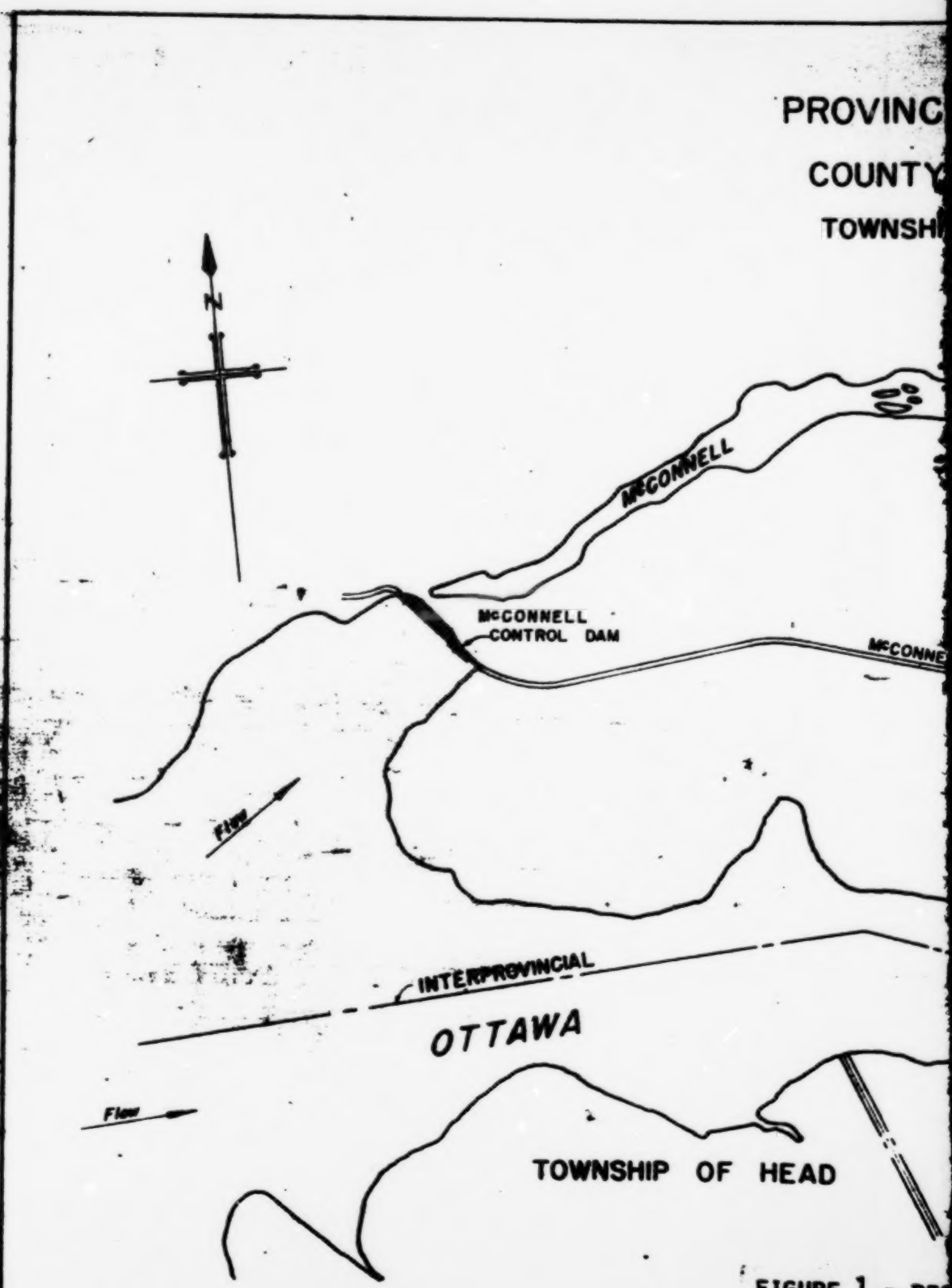


FIGURE 1 - DES

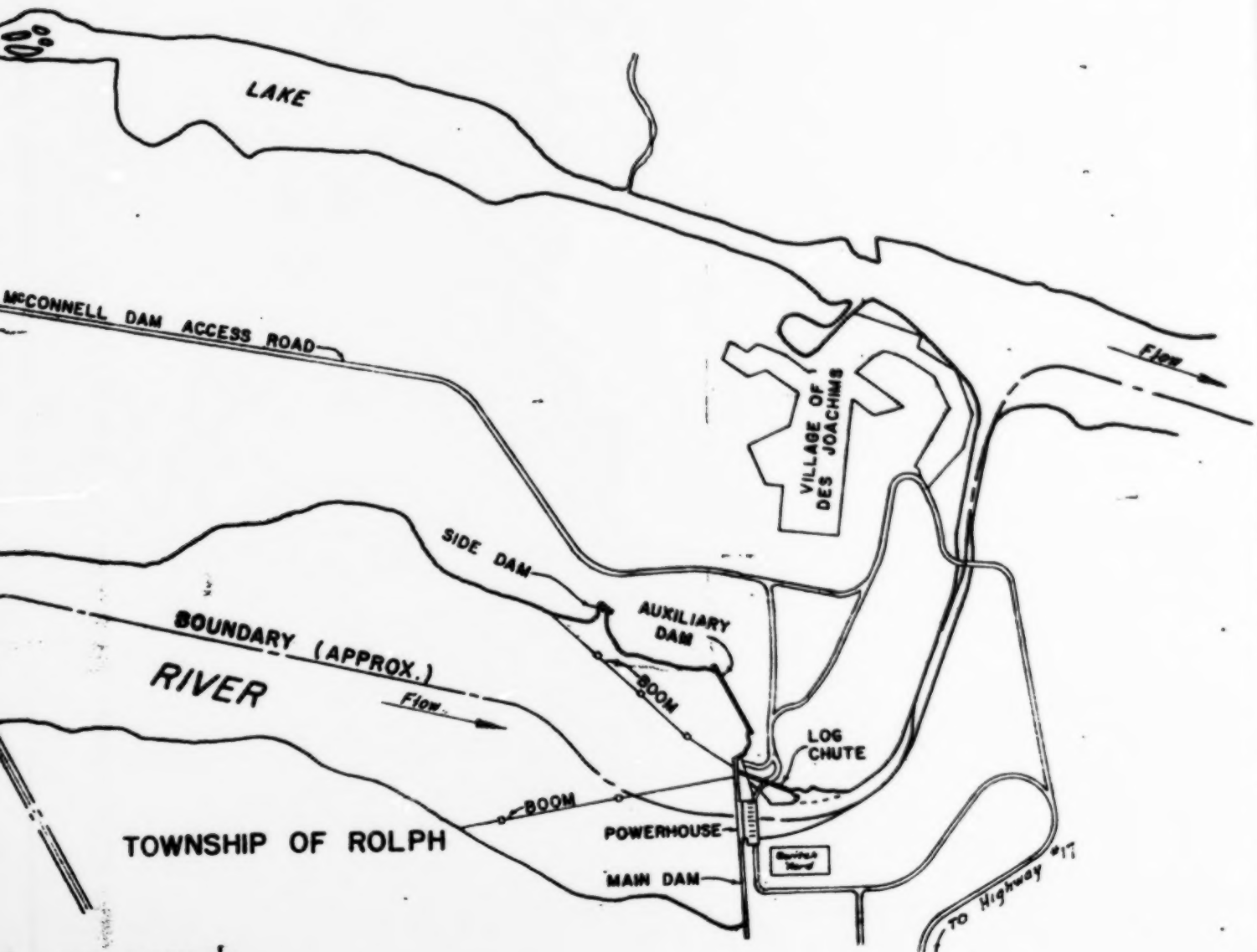
GENERAL ARR

SCALE - 1 INCH =

INCE OF QUEBEC

NTY OF PONTIAC

NSHIP OF ABERDEEN



1 - DES JOACHIMS

L ARRANGEMENT

- 1 INCH = 2000 FEET.

PART OF DRAWING 254-C-57

FIGURE 2 - SURVEY MONUMENTS - LEFT BANK OF DES JOACHIMS MAIN DAM

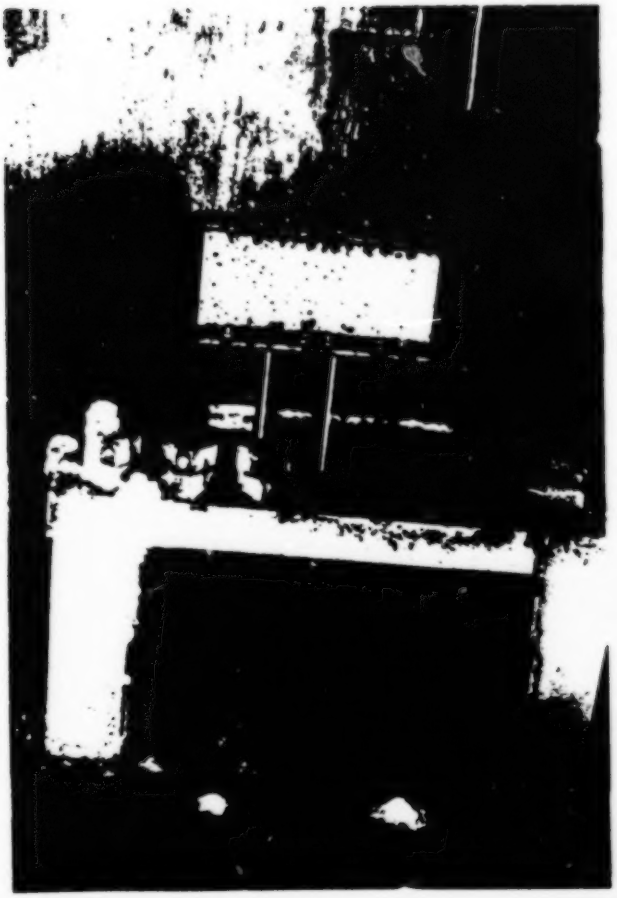


FIGURE 3 - CONDITION OF NORMAL PENDULUM ON MARCH 24, 1986 (DES JOACHIMS MAIN DAM 23+28 U/S SIDE OF INSPECTION TUNNEL)

MAPS NOT

FILMED

CARTES

OMISES